Sumit Mukhopadhyay

Scientist
Earth Sciences Division
Lawrence Berkeley National Laboratory

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Summary of Research Interest

Modeling and numerical simulation of multiphase, multi-component reactive and non-reactive transport in saturated and unsaturated porous and fractured media

Subsurface carbon dioxide sequestration

Modeling of heat and vapor transport processes in geothermal reservoirs

Modeling of reactive transport of natural isotopic tracers in geothermal reservoirs

Biogeochemical transport modeling for microbial reduction of toxic metals in groundwater

Feedback of reactive transport processes on flow

Flowing fluid temperature logging for characterization of fractured unsaturated zone

Mathematical modeling of fluid flow, heat and mass transport processes in air-gap membrane distillation for sea water purification

Multiscale transport phenomena and upscaling of transport processes

Education

1990-1995 Ph.D., Chemical Engineering, University of Southern California, Los Angeles, USA

1983-1987 B.S., Chemical Engineering (Honors), Jadavpur University, Calcutta, India

Professional Experience

Since 2004 Career Scientific Staff, Lawrence Berkley National Laboratory

1998-2004 Scientist, Lawrence Berkeley National Laboratory

1995-1997 Postdoctoral Research Associate, Purdue University

1990-1995 Teaching and Research Assistant, University of Southern California

1988-1989 Assistant Director, Oil & Natural Gas Commission, India.

Awards & Honors

2008 *Certificate of Accomplishment*, OCRWM Lead Laboratory for Repository Systems

2007 **Outstanding Performance Award***, Lawrence Berkeley National Laboratory*

2004 Commitment to Excellence Award*, US Department of Energy*

2004	Star Award, Bechtel SAIC
2003	Significant Contribution Spot Award, Lawrence Berkeley National Laboratory
2000	*Membership in Sigma Xi Scientific Honor Society for Significant Contributions*
1999	Biography published in Marquee's Who's Who in Science and Technology, Who's Who in America, and Who's Who in the World
1995	Outstanding Academic Achievement Award, University of Southern California
1994	John J. Watumul Scholarship, University of Southern California
1981-1987	National Scholarship, Govt. of India

Professional Activities

June 2010	Organizer and Session Chair, Flow-Induced Alterations in Porous Medium Properties and Its Implications on Transport, Third International Conference on Porous Media and Its Applications in Science, Engineering, and Industry, Montecatini Terme, Italy, June 20-25, 2010.
September, 2008	Session Chair, Characterization and Property Measurements II, 2008 IHLRWMC, American Nuclear Society, Las Vegas, NV, September 7-11,2008.
April 2001	Session Chair, Coupled Processes II, 9th International High-Level Radioactive Waste Management Conference, American Nuclear Society, Las Vegas, NV, April, 2001

Reviewer, Water Resources Research

Reviewer, Advances in Water Resources

Reviewer, Chemical Engineering Science

Reviewer, SPE Journal

Reviewer, Transport in Porous Media

Reviewer, Journal of Porous Media

Reviewer, Journal of Contaminant Hydrology

Reviewer, Journal of Hydraulic Engineering

Reviewer, Journal of Hydrology

Reviewer, Journal of Nonlinear Dynamics

Reviewer, Vadose Zone Journal

Member, American Society of Chemical Engineers

Member, American Chemical Society

Member, American Geophysical Union

Member, Materials Research Society

Member, Society for Industrial and Applied Mathematics

Book Chapter

1994 M. Sahimi and **S. Mukhopadhyay**
Fractals: Basic Concepts and Selected Applications
Encyclopedia of Telecommunications, Froelich and Kent, Eds., Volume 8, 219-269, Marcel Dekker, New York, NY

Selected Publications in Refereed Journals

2009 Y.W. Tsang, J.T. Birkholzer, **and S. Mukhopadhyay**
Modeling of Thermally-Driven Hydrological Processes in Partially-Saturated Fractured Porous Media, *Reviews of Geophysics*, 47, RG3004, doi:10.1029/2008RG000265.

2009 **S. Mukhopadhyay**, E.L. Sonnenthal, and N. Spycher, Modeling of Coupled Heat Transfer and Reactive Transport Processes in Porous Media: Application to Seepage Studies at Yucca Mountain, Nevada, *Journal of Porous Media,* Volume 12, No. 8, pp. 725-748, doi:10.1615/JporMedia.v12.i8.10.

2009 **S. Mukhopadhyay,** Y. W. Tsang, and S. Finsterle, Parameter estimation from flowing fluid temperature logging data in unsaturated fractured rock using multiphase inverse modeling, *Water Resour. Res.*, 45, W04414, doi:10.1029/2008WR006869.

2008 **S. Mukhopadhyay** and Y. W. Tsang, Determination of transport properties from flowing fluid temperature logging in unsaturated fractured rocks: Theory and semi-analytical solution, *Water Resour. Res.*, 44, W10424, doi:10.1029/2008WR006860.

2008 M. B. Kowalsky, J. T. Birkholzer, J. Peterson, S. Finsterle, **S. Mukhopadhyay**, and Y. Tsang, Sensitivity Analysis for Joint inversion of Ground-Penetrating Radar and Thermal-Hydrological Data From a Large-Scale Underground Heater Test
Nuclear Technology, Vol. 164, No. 11, pp. 169-179.

2007 **S. Mukhopadhyay**, Y.W. Tsang, and J.T. Birkholzer, Estimation of Field-Scale Thermal Conductivities of Unsaturated Fractured Rocks From In Situ Temperature Data, *Water Resources Research*, 43, W09418, doi: 10.1029/2006WR005283.

2006 **S. Mukhopadhyay**, E.L. Sonnenthal, and N. Spycher, Modeling Coupled Thermal-Hydrological-Chemical Processes in the Unsaturated Fractured Rocks at Yucca Mountain, Nevada: Heterogeneity and Seepage
Physics and Chemistry of the Earth, doi: 10.1016/j.jpce.2006.04.018, 31, 626-633

2006 Y.S. Wu, **S. Mukhopadhyay**, K. Zhang, and G.S. Bodvarsson
A Mountain-Scale Thermal-Hydrologic Model for Simulating Fluid Flow and Heat Transfer in Unsaturated Fractured Rock
Journal of Contaminant Hydrology, doi: 10.1016/j.conhyd.2006.02.015, 86, 128-159

2004 J.T. Birkholzer, **S. Mukhopadhyay**, and Y.W. Tsang
The Impact of Preferential Flow on the Vaporization Barrier Above the Waste Emplacement Drifts at Yucca Mountain Nevada
Nuclear Technology, 48(2), 138-150, 2004

2004 J.T. Birkholzer, **S. Mukhopadhyay**, and Y.W. Tsang
Modeling Seepage Into Heated Waste Emplacement Tunnels in Unsaturated Fractured Rock
Vadose Zone Journal, 3, 819-836

2003 **S. Mukhopadhyay** and Y.W. Tsang
Uncertainties in Coupled Thermal-Hydrological Processes Associated With the Drift-Scale Test at Yucca Mountain, Nevada
Journal of Contaminant Hydrology, 62-63, 595-612

2002 **S. Mukhopadhyay** and Y.W. Tsang
Understanding the Anomalous Temperature Data From the Large Block Test at Yucca Mountain, Nevada
Water Resources Research, 38(10), 28-1–28-12

2000 **S. Mukhopadhyay** and M. Sahimi
Calculation of the Effective Permeabilities of a Heterogeneous Porous Medium
Chemical Engineering Science, 55, 4495-4513

1998 **S. Mukhopadhyay** and J.H. Cushman
Monte Carlo Simulation of Contaminant Transport: I. Long-Range Correlations in Fracture Conductivity
Transport in Porous Media, 31, 145-181

1998 **S. Mukhopadhyay** and J.H. Cushman
Monte Carlo Simulation of Contaminant Transport: II. Morphological Disorder and Percolation
Transport in Porous Media, 31, 183-211

1998 **S. Mukhopadhyay** and J.H. Cushman
Diffusive Transport of Volatile Pollutants in Non-Aqueous Phase Liquid Contaminated Soil: A Fractal Model
Transport in Porous Media, 30, 125-154

1997 **S. Mukhopadhyay** and J.H. Cushman
Monte Carlo Simulation of Radioactive Contaminant Transport in Fractured Geologic Media: Disorder and Long-Range Correlations
Materials Research Society Symposium Proceedings on *Scientific Basis for Nuclear Waste Management*, 465, 885-892

1996 M. Sahimi and **S. Mukhopadhyay**
Scaling Properties of a Percolation Model With Long-Range Correlations
Physical Review E, 54(4), 3870-3880

1994 **S. Mukhopadhyay** and M. Sahimi
Scaling Behavior of Permeability and Conductivity Anisotropy Near the Percolation Threshold
Journal of Statistical Physics, 74(5-6), 1301-1308

Selected Technical Reports

2007 **Mukhopadhyay, S.**, Spycher, N., Sonnenthal, E.L., Zhang, G., and Finsterle, S.
THC Sensitivity of Heterogeneous Permeability and Capillarity Effects
ANL-NBS-HS-000047 REV 01, Lead Laboratory Sandia National Laboratory, Las

Vegas, Nevada.

2007 Spycher, N., Sonnenthal, E.L., Zhang, G., and **Mukhopadhyay, S.**, Drift-Scale THC Seepage Model, MDL-NBS-HS-00001 REV 05, Lead Laboratory Sandia National Laboratory, Las Vegas, Nevada.

2006 Spycher, N**., Mukhopadhyay, S.**, and Sonnenthal, E.L., THC Sensitivity of Repository Edge and Heterogeneous Permeability Effects, ANL-NBS-HS-000047 REV 00, Bechtel SAIC, Las Vegas, Nevada.

2005 Birkholzer, J.T., **Mukhopadhyay, S.**, and Tsang, Y.W., The Drift Scale Coupled Processes (DST and TH Seepage) Models, MDL-NBS-HS-00015 REV 02, Bechtel SAIC, Las Vegas, Nevada.

2004 Birkholzer, J.T., **Mukhopadhyay, S.**, and Tsang, Y.W., The Drift Scale Coupled Processes (DST and TH Seepage) Models, MDL-NBS-HS-00015 REV 01, Bechtel SAIC, Las Vegas, Nevada.

2003 Birkholzer, J.T., **Mukhopadhyay, S.**, and Tsang, Y.W., The Drift Scale Coupled Processes (DST and TH Seepage) Models, MDL-NBS-HS-00015 REV 00, Bechtel SAIC, Las Vegas, Nevada.

2003 Wu, Y-S., **Mukhopadhyay, S**., Sonnenthal, E.L., Rutqvist, J., and Zhang, K. Mountain-Scale coupled processes (TH/THC/THM) models MDL-NBS-HS-00007 REV 01, Bechtel SAIC, Las Vegas, Nevada.

2003 Liu, H.H., Wu, Y-S., Ahlers, C.F., and **Mukhopadhyay, S**., Analysis of hydrologic property data, ANL-NBS-HS-00014 REV 01, Bechtel SAIC, Las Vegas, Nevada.

Selected Conference Proceedings/Presentations/Invited Talks

2010 **Mukhopadhyay, S.**, S.-Y. Yang, H.-D., Yeh, and J.T. Birkholzer, Transient pressure response of a gas reservoir arising from supercritical carbon dioxide injection through a partially-penetrating well: An analytical solution, 10th International Conference on Greenhouse Gas Control Technologies, RAI, Amsterdam, The Netherlands, September 19-23, 2010.

2010 **Mukhopadhyay, S.**, A coupled multiphase fluid flow and heat and vapor transport model for air-gap membrane distillation, Third International Conference on Porous Media and Its Applications in Science, Engineering, and Industry, Montecatini Terme, Italy, June 20-25, 2010.

2009 Hazen, T.C., E.L. Sonnenthal, **S. Mukhopadhyay**, C.I. Steefel, P.E. Long, and B. Faybishenko, Field and numerical study of reductive bioimmobilization of Cr(VI) in groundwater at Hanford 100-H site, *Eos Trans. AGU*, 90(52), Fall Meet. Suppl., Abstract H13B-0943.

2009 Christensen, J.N., E.L. Sonnenthal, S. T. Brown, M.E. Conrad, L. Yang, **S. Mukhopadhyay**, C.I. Steefel, B. Faybishenko, and T.C. Hazen, Using Cr isotopic measurements and reactive transport modeling to monitor stimulated bio-containment at the 100H test site, Hanford, Washington, *Eos Trans. AGU*, 90(52), Fall Meet. Suppl., Abstract H13B-0942.

2008 **Mukhopadhyay, S.,** E.L. Sonnenthal, B. Faybishenko, and S. Hubbard**,** A reactive transport model for lactate-stimulated chromium reduction at Hanford 100 H Site

transport model for lactate-stimulated chromium reduction at Hanford 100-H Site, XVII International Conference on Computatiional Methods in Water Resources, San Francisco, CA, July 6-10, 2008.

2008 **Mukhopadhyay, S**., and Y. Tsang, Flowing fluid temperature logging in boreholes: A novel approach for estimating transport properties of fractured porous media, XVII International Conference on Computatiional Methods in Water Resources, San Francisco, CA, July 6-10, 2008.

2007 **Mukhopadhyay, S.**
Feedback of coupled thermal-hydrological-chemical processes on groundwater flow in the unsaturated zone, Department of Civil Engineering, Indian Institute of Science, Bengaluru, India, December 20, 2007 (**Invited**)

2007 **Mukhopadhyay, S.**
Modeling heat transfer and multiphase transport in porous media: Concepts and some applications, Indian Institute for Science Education and Research, Kolkata, India, December 14, 2007 (**Invited**)

2007 **Mukhopadhyay, S.**, E.L. Sonnenthal, and N. Spycher
Modeling of coupled heat transfer and reactive transport processes in porous media: application to seepage studies at Yucca Mountain, Nevada, Second International Conference on Porous Medium and Its Applications in Science, Engineering, and Industry, Engineering Conferences International, Kauai, HI, June 17-21, 2007

2007 **Mukhopadhay S.**, E.L. Sonnenthal, and N. Spycher
Feedack of coupled thermal-hydrological-chemical processes on flow in unsaturated fractured rock: application in seepage modeling studies, Groundwater Summit, National Groundwater Association, Albuquerque, NM, April 29-May 3, 2007. LBNL-61967 Abs.

2006 Hubbard, S., K. Williams, T. Scheibe, J. Peterson, J. Chen, **S. Mukhopadhyay**, E.L. Sonnenthal, and C.I. Steefel, Improved understanding of natural system processes through coupling of geophysical characterization and numerical modeling approaches, *Eos. Trans. AGU*, 87 (52), Fall Meet. Supple. (**Invited**)

2006 Wu, Y-S., **S. Mukhopadhay**, K. Zhang, and G.S. Bodvarsson
The Influence of Proposed Repository Thermal Load on Multiphase Flow and Heat Transfer in the Unsaturated Zone of Yucca Mountain
International High Level Radioactive Waste Management Conference, Las Vegas, Nevada, American Nuclear Society, April 30-May 2, 2006 (LBNL-59783)

2006 Wu, Y-S., **S. Mukhopadhyay**, K. Zhang, and G. S. Bodvarsson
Modeling Coupled Processes of Multiphase Flow and Heat Transfer in the Unsaturated Fractured Rock
Computational Methods in Water Resources, XVI International Conference. Copenhagen, Denmark, UTD, June 18-22, 2006 (LBNL-58677)

2006 Hubbard, S., J. Chen, Y. Fang, K. Williams, **S. Mukhopadhyay**, E. Sonnenthal, K. McFarlane, N. Linde and T. Scheibe
Improved parameterization of hydrological models and reduction of geophysical monitoring data ambiguity through joint use of geophysical and numerical modeling methods
CWMR XVI -Computational Methods in Water Resources, Copenhagen, Denmark, June 19-22, 2006 (LBNL-59834) (**Invited**)

2006 Kowalsky, M., Birkholzer, J.T., Finsterle, S., Peterson, J., **Mukhopadhyay, S.**, and Tsang, Y.

Joint inversion of ground-penetrating radar and thermal-hydrological data collected during a large-scale heater test
Proceedings of the 5th TOUGH Symposium, Lawrence Berkeley National Laboratory, Berkeley, CA, May, 2006 (**Invited**)

2005 **Mukhopadhyay, S**., Sonnenthal, E.L., and Spycher, N.
Modeling coupled thermal-hydrological-chemical processes at Yucca Mountain: flow channeling and seepage into drifts
Migration'05, Avignon, France, September 18-23, 2005

2004 **Mukhopadhyay, S.**
An integral finite-difference approach for modeling heat transfer and multiphase flow in large-scale porous media: Concepts and applications
Presented to the Department of Chemical Engineering, Indian Institute of Technology, Kharagpur, June, 2004 (**Invited**)

2004 Mukhopadhyay, S.
A finite-integral approach for modeling heat transfer and multiphase transport in large-scale porous media
Presented to the Department of Chemical Engineering, Indian Institute of Technology, Guwahati, January, 2004 (**Invited**)

2003 Birkholzer, J.T., **Mukhopadhyay, S.**, and Tsang, Y.
Modeling water seepage into heated waste emplacement drifts at Yucca Mountain
Proceedings of the 4th TOUGH Symposium, Lawrence Berkeley National Laboratory, Berkeley, CA, May, 2003.

2003 **Mukhopadhyay, S.**
Modeling heat-driven multiphase transport at Yucca Mountain, Nevada
Presented to the Department of Chemical Engineering, Indian Institute of Technology, Kanpur, India, April, 2003 (**Invited**)

2003 Birkholzer, J.T., **Mukhopadhyay, S.**, and Tsang, Y.
Analysis of the vaporization barrier over emplacement drifts
Proceedings of the 10th High-Level Radioactive Waste Management Conference, American Nuclear Society, Las Vegas, NV, March 30-April 2, 2003

2001 **Mukhopadhyay, S.** and Tsang, Y.
Vapor transport through fractures and other high-permeability paths: Its role in the Drift Scale Test at Yucca Mountain
Proceedings of the 2001 Annual Fall Meeting, American Geophysical Union, San Francisco, CA, December, 2001

2001 **Mukhopadhyay, S.**
Understanding the thermal-hydrological processes from the Drift Scale Test: Measured data, numerical models and uncertainties
13th Thermal Test Workshop, Sandia National Laboratory, Albuquerque, NM, October, 2001

2001 Wagner, R. A., Ballard, S., Blair, S. C., and **Mukhopadhyay, S.**
A methodology for validation of process models used to simulate thermal tests at Yucca Mountain
Proceedings of the 38th. U.S. Rock Mechanics Symposium, American Rock Mechanics Association, Washington, DC, July 2001

2001 **Mukhopadhyay, S.**
Predictive simulations of the cooling phase in the Drift Scale Test at Yucca Mountain, Nevada
12th Thermal Test Workshop, Office of the Civilian Radioactive Waste Management, Las Vegas, NV, June 2001

2000 **Mukhopadhyay, S.** and Tsang, Y.
Integrative analysis of measured and simulated temperature data from the Drift Scale Test at Yucca Mountain
11th Thermal Test Workshop, Lawrence Berkeley National Laboratory, Berkeley, CA, October, 2000

2000 **Mukhopadhyay, S.**
Predictive simulations of the thermal response from the Cross Drift Thermal Test
10th Thermal Test Workshop, Lawrence Livermore National Laboratory, Livermore, CA, March, 2000

1999 Tsang, Y. and **Mukhopadhyay, S.**
Analysis of the coupled heat, moisture and vapor transport processes of the Drift Scale Test at Yucca Mountain
Proceedings of the Annual Fall Meeting of the American Geophysical Union, San Francisco, CA, December, 1999 (**Invited**)

1999 **Mukhopadhyay, S.** and Tsang, Y.
Understanding the thermal-hydrology in unsaturated fractured rock: The Large Blcok Test
Proceedings of the Annual Fall Meeting of the American Geophysical Union, San Francisco, CA, December, 1999

1999 **Mukhopadhyay, S.**
TOUGH2 simulations of the DST: UZ Drift Scale property set and TTFY99 property set
9th Thermal Test Workshop, Sandia National Laboratories, Albuquerque, NM, November, 1999

1997 **Mukhopadhyay, S.** and Cushman, J. H.
Monte Carlo simulation of contaminant transport: Disorder and fracture-matrix interflow
Proceedings of the Annual Fall Meeting of the American Institute of Chemical Engineers, Los Angeles, CA, November, 1997

1997 **Mukhopadhyay, S.**
Monte Carlo simulation of radioactive contaminant transport in the geologic media near Yucca Mountain, Nevada
4th. SIAM Conference on Mathematical and Computational Issues in Geosciences, Albuquerque, NM, June, 1997

1996 **Mukhopadhyay, S.** and Cushman, J.H.
Monte Carlo simulation of contaminant transport in fractured geologic media
American Geophysical Union Annual Fall Meeting, San Francisco, CA, December, 1996

1996 **Mukhopadhyay, S.** and Cushman, J.H.
Monte Carlo simulation of radioactive contaminant transport in fractured geologic media: Disorder and long-range correlations
Materials Research Society Annual Fall Meeting, Boston, MA, December, 1996

(**Invited**)

1992 **Mukhopadhyay, S.** and Sahimi, M.
Heat transfer and two-phase flow in heterogeneous porous media
Proceedings of the Western Regional Meeting of SPE, Bakersfield, California, 30th. March - 2nd. April, 1992